The notes that follow were prepared as I reviewed some of the information on the Goliad Project received from Mr. Art Dohmann, president of the Goliad County Groundwater Conservation District (GCGCD) during the two meetings with the Goliad County citizens and their consultants held in the Regional office. Judging by the nature of the information, it became apparent that the GCGCD wants EPA to look at some aspects of the Aquifer Exemption (AE) request associated with the Project, which up to this point seem to have been of very little or no concern to other involved parties.

Therefore, one of the goals of my review has been to conduct a preliminary estimate of the degree to which water production at the wells identified in the GCGCD data may affect the flow in the portion of the Aquifer proposed for exemption. This has been accomplished by performing a drawdown analysis involving these wells. I also call attention to the presence of ground water-surface water interaction in the area, as a way of preparing for potential questions at the upcoming Public Meeting.

I want to share these notes, and complementary Power Point presentation, with you, hoping that you may have time to review them and may have comments/suggestions on points of discussion that may enhance our ability to address issues that may be brought up during the scheduled Public Meeting in Goliad. Here is what I have been looking at and a brief description of how I used this information:

Slide 1:

This slide shows the potentiometric surface in the Gulf Coast Aquifer in several Texas Counties in 1990. Mr. Dohmann spoke to me about the importance of a water supply well location map (seen in Slide 7) as a source of information on Aquifer water usage in the area around the acreage permitted for mining. So, in order to get an idea of what a bigger picture of this Aquifer might show in terms of pressure drawdown patterns, I first browsed Raymond Hay's report (Reference 1). The map shown in Slide 1 comes from his report. The red arrows on the map point to the Cones of Depression (CODs) for the ground water supply systems in the cities of Victoria and Kingsville. These cities appear to be two of the points with the longest history of large withdrawals from the aquifer, so, it is no surprise that they stand out in this map.

Slide 2:

The map on this slide provides a close up of the Kingsville ground water supply system's COD in 1968-69, as presented in the Texas Water Development Board's (TWDB's) Report 173 (Reference 2). This map assisted in establishing the reliability of the aquifer average permeability value of 4700 md that I estimated. This figure was derived from information presented in Report 173, which listed a Coefficient of Transmissibility of 30000 GPD/Ft for the Goliad Aquifer in the region. The above permeability value facilitated conducting some of my analyses for the Aquifer in Goliad County using oil field units.

Slide 3:

The contour lines on this map show the estimated drawdown in the Aquifer resulting from production at the City of Victoria's, Victoria County, public water supply system. This system's 15 wells were assumed to have produced at 10% of their overall capacity of 10000 AcFt per year for 30 years. These wells have produced at their full capacity when required by drought conditions, but these events were not included in the analysis due to lack of information. Previous drawdown computations for the assumed

parameters and operating conditions showed that this ground water supply system may have induced a drawdown of about 7 feet in the area of the permitted mining operation. The red arrows seen on this map point to the approximate location of the permitted Production Area No. 1 (PA-1), and to the Coleto Creek Reservoir, which may be fed in part by the Aquifer.

Slide 4:

The map in this slide illustrates the location of the City of Goliad, the permitted mining site and the Coleto Creek Reservoir (see red arrows). A previous drawdown analysis for the two water supply wells in this city's public water supply system indicated that, for the assumed parameters and operating conditions, this ground water supply system may have contributed a drawdown of about 3 feet in the area of the permitted mine over a period of 30 years. No details on the completion of these two wells are available at this time.

Slide 5:

The boundaries for the permit area, the proposed exempted area and the permitted PA-1 (the area shaded in yellow) are shown in this map. The red arrow points to the approximate location of the PTW-14 well.

Slide 6:

Detail of PA-1, including the ring of monitoring wells, is provided by this slide. The red arrow points to the location of the PTW-14 well. This location was used as the point of reference for the drawdown analysis for the water supply wells in the Goliad Project's surrounding area and identified by the GCGCD.

Slide 7:

This well location map shows an outline of the Goliad Project permit area approved by TCEQ, and the water supply well population (160 total) in the surrounding 15 to 20 square miles. Goliad County has an area of 854 square miles. An oversize blue X is seen marking the approximate location of the PTW-14 well, located inside the permitted PA-1. The shown water supply wells, either supply drinking water (106) or provide water for agricultural and livestock managing activities (54). Numbers were assigned to these wells for map identification purposes, and their distances to the PTW-14 well were estimated for use in the pressure drawdown analysis discussed below.

Slide 8:

Seen here is a copy of Commissioner Ted Long's message providing an estimate for water usage and the driller's description of the lithology at his well, drilled and completed in June, 1993. No additional details on the completion of the Commissioner's well were available.

Slide 9:

Provides a schematic of the lithology at Commissioner Long's well. It can be seen that the confining zone atop Sand "A" in this well is only 4 feet thick, suggesting the possibility of an outcrop at lower elevations, near the Eighteenmile Creek.

Slide 10:

Depicts completion details for an area water supply well. Notice the possibility for crossflow between water sands in this well. Crossflow between zones in this area may occur not just at wells completed in this manner, but also at unplugged exploratory wells (numbering 60 at PA-1, see Slide 11)

Slide 12:

The red arrow points to Commissioner Long's well on this topographic map. The contour lines show that the ground level drops from about 208 feet at this well, to below 170 feet at the banks of the Eighteenmile Creek, hinting an interaction between ground and surface waters in this area.

Slides 13 and 14:

In the well logs in these two slides the Gamma Ray curve attests to the presence of uranium ore in the "B" Sand. These logs correlate quite well with the schematic for Commissioner Long's well, suggesting that continuity of Sands "A" and "B" in the area of interest may be a good assumption, and that a cumulative thickness of 100 feet for the two sands may be a reasonable first estimate. The sands were assumed to have a constant thickness throughout the area of interest for the analysis discussed below, even though some of the data seen here suggest that the sands can be thinner in some areas.

Slide 15:

The Table in this slide is a summary of the results of the engineering analysis of the flow conditions and resulting cumulative pressure drawdown in the "A" and "B" Sands, induced by ground water production at the 160 wells depicted in Slide 7. The observation point for this analysis was, as previously stated, the location of the PTW-14 well near the center of PA-1. The mathematical model used is similar to that used by the Direct Implementation Program for the injection performance analysis of Class II wells. The olive column in the Table shows the estimated cumulative drawdown in Feet at the observation point for all identified 160 water supply wells producing at 10 BPD each, over a 30 years period, for four probable average permeability values ranging from 1.0 to 4.7 Darcies.

Slide 16:

The Table in this slide is a summary similar to that seen in Slide 15, except that in this case the agricultural/livestock wells were assumed producing at 20 BWPD each. The purpose of this run was to analyze the sensitivity of the predictive scheme to the uncertainty of well producing rates data.

Slide 17:

This Table provides details on the results of the model for individual wells for an assumed permeability of 1.0 Darcy. Due to the large number of wells involved, only two groups of wells were selected for this Table: the ten wells closest to the PTW-14 well, and the ten most distant wells. This Table shows that the estimated individual drawdown contributions range from 1.5 inches for the closest well (1200 feet away) to 0.5 inches for the most distant one (roughly 5.5 miles away). A complete list of wells and associated drawdown values can be seen in the spreadsheet accompanying this discussion, which also includes a routine for individual well drawdown computations.

Slide 18:

The graph in this slide documents the range of values for water consumption per capita experienced by the El Paso Water Utilities (EPWU) over a period of 34 years. Per capita consumption steadily declined and then stabilized at a level of 133 gallons per day. The daily per capita water consumption for the City of Victoria analysis summarized in Slide 3 was estimated at 137 gallons. These figures contrast with the 80 gallons per day per person suggested for the Goliad Project area analysis, indicating that the drawdown values estimated by my review may be on the low side.

Slide 19:

An excerpt of a discussion on the Goliad Project provided by the GCGCD is seen on this slide. Parameters associated with the area proposed for aquifer exemption are listed along with the results of a volumetric analysis for this area. The discussed volumes have also been illustrated in equivalent oil field units. A comparison of these volumes indicates that the cumulative production of the identified water supply wells might roughly amount to between 10% and 20% of the water in place within the area proposed for an AE, depending on the number of zones considered for comparison.

Slide 20:

References.

ANALYSIS:

The estimated drawdown for individual water supply wells (Slide 17) might prompt someone to dismiss the possibility that the wells identified by the GCGCD do get water from the portion of the Aquifer proposed for exemption, especially since these wells are all located in a random pattern.

However, the drawdown data in the Tables in Slides 15 and 16 indicate that these wells, producing together, may have already contributed their own COD reaching into the PA-1 by drawing water from the portion of the aquifer proposed for exemption. In effect, the modeling results indicate that these wells are capable of contributing a drawdown equivalent to that of one single well located at a distance of about 9500 feet from the observation point, well PTW-14, if produced at 1600 BWPD, over the same period of time.

The above observations lead to the conclusion that, for modeling purposes and for the assumed conditions, the selected number of wells to be included in the model and the chosen length of production could sway the answers one way or the other. The results of this particular exercise point to the importance of accounting for the historical production of the wells. The lowest estimated drawdown value for the identified wells, roughly 3.1 feet at the observation point for an estimated average permeability of 4.7 Darcies (Slide 15), almost doubles the Aquifer's natural gradient of five feet per mile. There is, reportedly, significant water migration in this Aquifer.

The parameters used in this simplified modeling exercise may warrant revisions. In addition, a more complete modeling work for this Aquifer calls for the inclusion of aquifer recharge effects, the effects of ground water – surface water interactions and the effects of vertical migration (Slide 11).